Sensor Technologies and Sensor Materials for Small Satellite Missions related to Disaster Management

CANEUS Indo-US Cooperation

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Outline

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    - Academia, Small and large Industries, Govt. Support, Indo-US Forum
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Background (1 of 2)

- **Natural disasters in both India and the US cause humongous damages each year.**
  - Need to develop and demonstrate emerging tools and technique through international and bilateral Cooperation. (http://iaaweb.org/iaa/Summit/IAA_Study-Disaster_Management.pdf).
- **The major recommendation observed that "disaster monitoring requires constellation of satellites with different sensor capabilities.**
- **No single country can afford to develop such complete set of sensors and satellite system." "Also duplication of the activities causes loss of valuable time."**

Background (2 of 2)

- **Responsibility and role in forecasting, monitoring and mitigating disasters like floods, drought, typhoons, earthquakes, wild fires, windstorms, tidal events etc.**
  - In these Small satellite applications for disaster management have vital role in accomplishing the satellite missions
    - Temperature sensors, remote imaging systems, radars, magnetic sensors, IR and bolometers, pressure sensors etc. (Ref: Proceedings of 26^{th} AIAA / USU Conference on Small Satellites – Year 2012).

Concept

- Draws on the foundation of experience and technical excellence covering sensors technology and advanced materials for small (Micro and Nano) satellite applications derived from both India and USA
  - to foster collaboration among universities, industries and government agencies to meet the well-defined common needs of stakeholders from both countries.
- **Theme 1:** Technology Challenges and Needs
- **Theme 2**: Sensor Technology Status
- **Theme3:** Potential Nano/ Micro Satellite Mission Concepts

Theme 1: Technology Challenges and Needs

- Small Satellite System Architecture and Requirements
- Observation Parameters and Challenges
- Role of Nano/micro satellites in Disaster Management information Systems
- Ongoing Small Satellite Missions / Upcoming Missions
- Roles of Academia / Industries / Funding Bodies / Ministries in Technology Development Endeavors related to Small Satellite Sensors and Sensor Materials

Theme 2: Sensor Technology Status

- Sensors Materials/Devices
- Emerging Sensor Technologies (Research / Practices)
- Interfaces and Integration
- Proof of concept Tests – Use of Small Satellites as Test Vehicles
- Observations, Interpretation, and Data Correlation

Theme 3: Potential Nano/ Micro Satellite Mission Concepts

- <u>Panel Discussions: Defining Collaborative Nano/Microsat based missions for Disaster management"</u>
  - Disaster Scenario- 1 (Natural Disasters)
  - Disaster Scenario-2 (Man-made Disasters)
- Identification of Missions of Common Interest

- <u>Panel Discussions: Defining Specific Sensor Related Projects</u>
- Sensor Technologies Related to Mission of Common Interests
- Identification of Technology Gaps in Sensor Design, Fabrication, Integration and Testing

- Outlining of one or two specific projects for advancement of sensor technologies (Deliverables / Cost Sharing / Facility Sharing / Time Schedules / Cost Estimates / Exchange of Human Resources)

Purpose

- **Provide participants and potential stakeholders with an interactive, in-depth assessment of current technology development requirements**
  - Identify technology gaps and also prioritize them with reference to the near-term and long-term needs of Indo US small satellite missions.
- **Articulate and outline the joint-development proposals** related to sensors and sensor materials for micro-nano satellites
- **Facilitate creating a technology-platform and also a tangible working-model**

Bilateral Event

- **The core premise of the proposed workshop is that complementary skill sets from across two nations are needed** *to rapidly and cost-effectively transform emerging sensors and materials technologies into practical devices for space application.*
- **An essential step in realizing this vision:**
  - the Workshop will build on the complementary core expertise from key stakeholders.
  - Participants will represent both the end users, and technology developers.
  - Ultimately, the Workshop participants will collectively define a program implementation plan and action items, within the Indo-US cooperation framework**.**

- **The most important factor that justifies proposed workshop is the need a technology-platform and also a tangible working-model that can provide long-term sustenance to the collaborations**

GOES-R Brief Overview

(Geostationary Operational Environmental Satellite R-Series)

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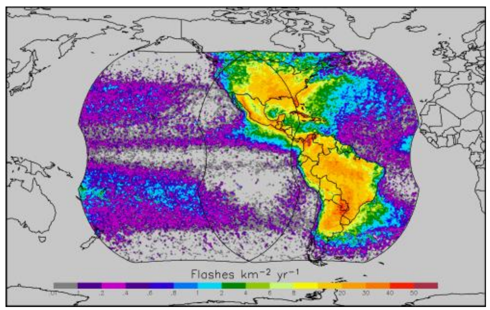
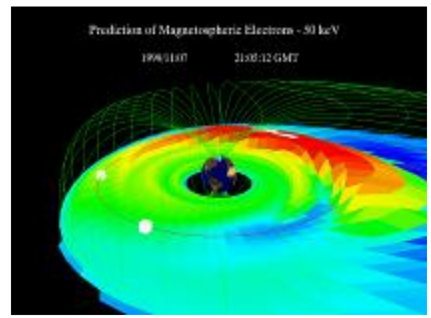
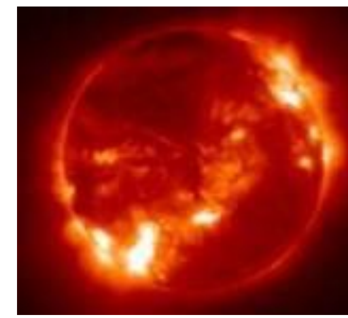
GOES-R Mission Overview

- **GOES-R is the next generation of GOES satellites that will provide a major improvement in quality, quantity, and timeliness of data collected**

Earth Pointing		In-Situ	Sun Pointing
Visual & IR Imagery	**Lightning Mapping**	**Space Weather Monitoring**	**Solar Imaging**







Images Credit: NASA

- *Advanced Baseline Imager (ABI)*
- *Geostationary Lightning Mapper (GLM)*
- *Space Environment in-Situ Sensor Suite (SEISS)*
- *Magnetometer*
- *Solar Ultra-Violet Imager (SUVI)*
- *Extreme UV/X-Ray Irradiance Sensors (EXIS)*

- **New and improved capabilities for:**
  - **Decreased lead times for severe weather warnings**
  - **Better storm tracking capabilities**
  - **Solar, space weather, and climate analyses**
  - **Advanced products for aviation, transportation, commerce**

Spacecraft Features that Allow Near-Continuous Observation

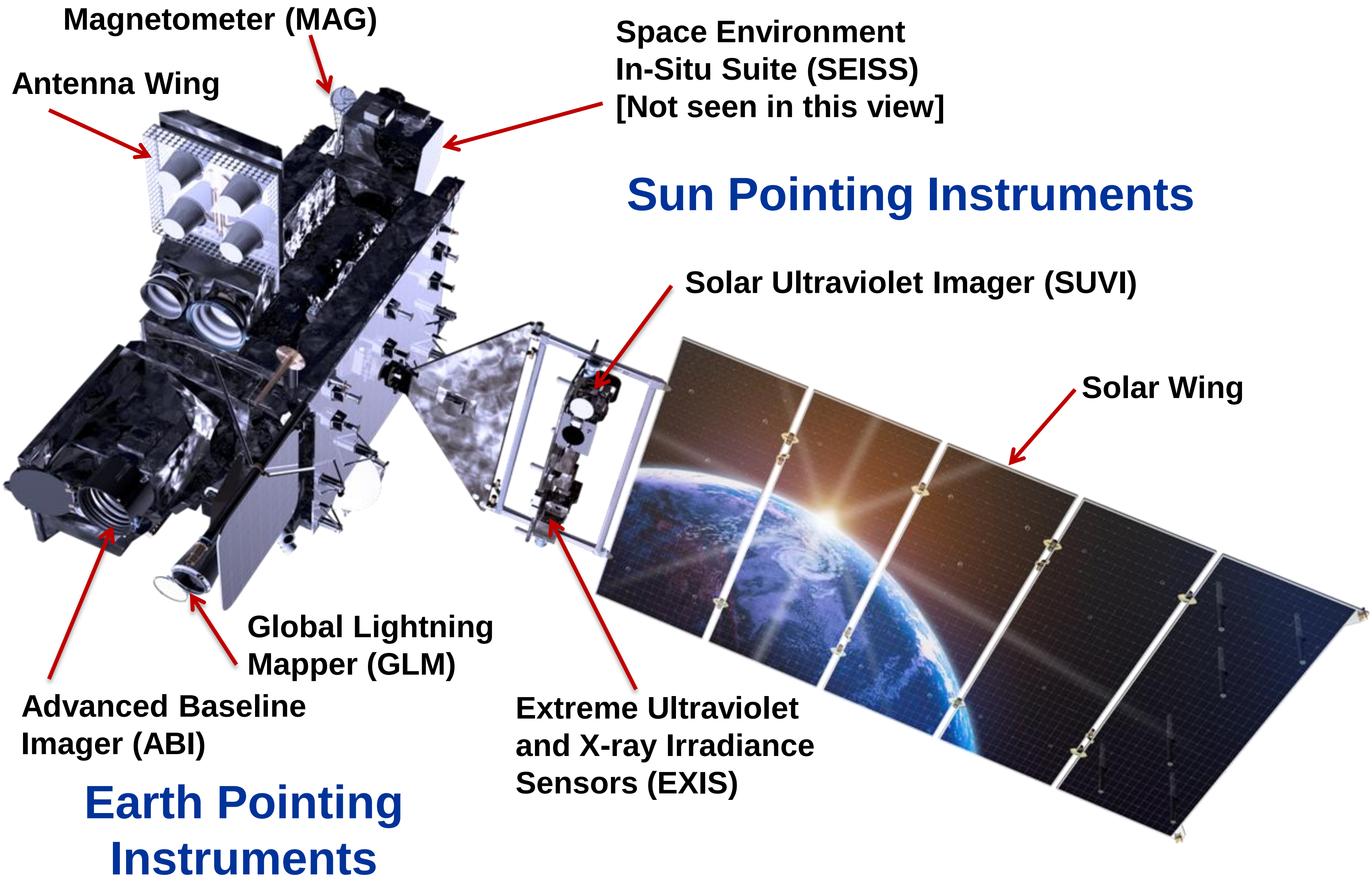
- **GOES-R has Operational Capability for Near-Continuous Observation**
- **Enhances Ability to Observe, Predict, Communicate, and Maximize Weather/Climate Data at New Level of Fidelity and Timeliness**
- **Spacecraft Features that Allow Near-Continuous Observation and High-Fidelity Accurate Science Data Collection**
  - **Operate-through station-keeping**
  - **Operate-through momentum adjust maneuvers**
  - **Satellite does not require a yaw flip at any time of the year**

Spacecraft Features that Allow Near-Continuous Observation (concl)

- **Fault management architecture allows for fault containment at the component level and avoidance of unnecessary safe hold entries for the satellite**
- **Vibration isolation for the Earth-pointed instruments**
- **Precision mechanisms and control electronics and an identification-based active solar array vibration damping controller for Sun-pointed instruments**

• **Together, these features strive toward 100% (Near-Continuous Observation)** availability for this advanced weather satellite while maximizing science data collection (High-Fidelity Observation), assuring the acquisition and downlink of vital Earth and space observation data used for weather and climate prediction

GOES-R Architectural Overview



GOES Functions Overview

- GOES spacecraft operate as a two-satellite constellation in geosynchronous orbit above the equator and observes 60 percent of the Earth
- Orbital locations are 75W longitude (CONUS East Coast) and 137W longitude (CONUS West Coast)
- Spacecraft enable the primary Imager and Geostationary Lightning Mapper (GLM) sensors to constantly face the Earth
  - Produce images of the clouds, and monitor the Earth's surface and ocean surface temperatures
  - Maps total lightning (in-cloud and cloud-to-ground) activity with near-uniform spatial resolution of approximately 10 km continuously day and night over the Americas and adjacent ocean regions. Provides early indication of storm intensification and severe weather events, improved tornado warning lead time of up to 20 minutes or more, and data for long-term climate variability studies.
- Measure the solar and geosynchronous space environment (space weather)
  - An Energetic Particle Sensor (EPS) package
  - Two magnetometer sensors (magnetic storms can affect other satellites and power infrastructure [power grid] on Earth. With warning, steps can be taken to mitigate the effects.)
  - Solar X-ray Sensor (XRS)

Expected Outcomes Of Proposed Workshop

- **Outcome 1: The workshop provides participants and potential stakeholders with an interactive, in-depth assessment of current technology development requirements**
  - Assessment of the current strengths of the indo US groups and also identification technology gaps with reference to the near-term and long-term needs of Indo US small satellite missions.
- **Outcome 2: These workshops participants would articulate and outline the joint-development proposals**
  - This is the most direct outcome that would enable immediate action plan for efforts for serving the larger socio-economic interest of both the countries through technology endeavours.
- **Outcome 3: The workshop interactions will facilitate creating a technology-platform and also a tangible working-model.**
  - The positive impact of this outcome will stretch beyond the workshop proceedings in providing a long-term sustenance model for mutually fulfilling collaborations.

Concluding Remarks

- ***Primary Objective of the Workshop:***
  - *Identification and further development of mutually agreed small-satellite sensor technologies with an ultimate aim of serving the disaster management needs.*
- **Uniqueness of the workshop :**
  - Ability to network experienced Indo US groups with rich credentials in sensors and sensor materials such that joint development projects are engendered through effective sharing of risks, costs and resources.
  - Technology Focus Groups Driven to Succeed